Parasitism of the Common Eastern Froglet *Crinia signifera* by flies of the genus *Batrachomyia* (Diptera: *Chloropidae*): Parasitism rates and the influence on frog condition

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ABSTRACT

The presence of Batrachomyia larvae was recorded on 1319 frogs captured in pitfall traps as part of a study on the population ecology of the Common Eastern Froglet *Crinia signifera* breeding at a pond at Darkes Forest, New South Wales. The body length, body mass and reproductive status of each frog captured were also recorded to compare the physical state of parasitised frogs with unparasitised frogs. Nineteen females and eleven males were recorded with parasites. The body condition (length/mass) of parasitised males was significantly less than for unparasitised males, but was not significantly different for female frogs. Females with parasites had a lower mean condition than unparasitised females, but the greater body size of females appears to reduce the relative effect of the parasite. Fifteen of the parasitised female frogs had oviducal eggs and three were known to have subsequently laid eggs. Hence larvae do not suppress the reproduction of the host frog.

Key words: Parasitism, *Crinia signifera*, *Batrachomyia*, condition

INTRODUCTION

Duellman and Trueb (1986) reviewed the arthropod parasites of amphibians and identified several different groups that infested anurans. They also identified that little is known about the effects of these parasites on their host. The only study reported by them that investigated the impacts of a parasite was by Meisterhans and Heusser (1970) where larvae of the dipteran fly genus *Lucilia* were recorded parasitising four species of European frogs. These larvae burrowed into the heads of the frogs through the nostrils and caused the death of the host frog in 13 of 14 cases.

In Australia, larvae of the Dipteran fly genus *Batrachomyia* (known as "frog flies") have been recorded parasitising a number of species of frogs (McAlpine 1955; Tyler 1976). McAlpine (1955) provided the most detailed study on the biology of this group of flies. He found that the larvae reside in the lymph spaces beneath the skin on the backs of frogs where they ingest the blood of the host frog. The means of entry of the larva into the host body is unclear. Adult flies lay eggs directly on the ground and he suggested that the larvae either crawl onto the frog and burrow under its skin, or they are ingested by the frog and burrow their way through its tissues and into the lymph spaces. Prior to pupation, the larvae emerge from under the skin, drop to the ground and move to a darkened, covered position to pupate.

The effect of *Batrachomyia* larvae have on the host frog is unclear. Krefft (1864) found that all frogs he observed died after the emergence of the larvae, but Skuse (1889) found that no frogs died when emergence occurred and concluded that Krefft's frogs may have died from other causes. McAlpine (1955) found no evidence for the feeding activity of the larvae killing the host. He did, however, find that 10% of the frogs died after the emergence of the larva, probably as the result of infections. Although parasites may not be lethal, they could have a significant negative effect on the relative health of the host frog through the continuous removal of blood. It would be expected that frogs with parasites would have a lesser mass than unparasitised frogs of the same body length.

The Common Eastern Froglet *Crinia signifera* is a small (males 24 mm, females 30 mm) myobatrachid frog from eastern Australia that has been recorded to be parasitised by *Batrachomyia*, probably *B. atricornis* (McAlpine 1955). When I commenced a study into the population ecology of this species (Lemckert 1991), I recorded parasitism in these frogs to determine the extent of parasitism by *Batrachomyia* larvae on froglets in the study population. Data obtained on the body length and mass of captured frogs also provided an opportunity to test for possible negative effects of the larvae on the health of host frogs.

STUDY AREA AND METHODS

The study was undertaken between August 1987 and May 1989 at a permanent pond (30 X 15 m) located at Darkes Forest, approximately 50 km south of Sydney, New South Wales. Frogs entering and leaving the pond area were captured in a pitfall-trap/drift-fence system that encircled the pond. This system consisted of 21 buckets (30-50 cm deep) connected by a 40 cm high vertical plastic fence placed 2-3 m from the water's edge. Each bucket was either open to only one side of the trap line or was divided into two halves by an aluminium sheet so that the direction of movement (into or out of the pond area) of captured frogs could be ascertained. Captured frogs were sexed, weighed to the nearest 0.01g using a Sartorius Electric Balance or a RCBS model 10.10 reloading scale (Ohaus Scale Corporation) and had their snout-urostyle length (SUL) measured to the nearest 0.1 mm using vernier callipers. They were then visually examined to determine if they carried *Batrachomyia* larvae and, if so, how many. Finally, each frog was toe-clipped and its back pattern and belly pattern recorded so that, in combination, each individual could be uniquely identified. The frogs were returned to the study site and released on the opposite side of the fence line to that on which they were captured.

The condition of both parasitised and non-parasitised frogs was assessed by dividing their measured body mass by their SUL. The higher the index, the better the body condition of the frog. In the case of frogs with parasites, their recorded mass included both the mass of the frog and that of the parasite. I corrected for the mass of the larva by reducing the mass of the frog by 3%, 5% or 7% for frogs carrying small, medium and large larvae respectively (see results for relative mass of larvae). A t-test was used to determine if the presence of fly larvae on both male and female frogs resulted in a significant decrease in their body mass.

RESULTS

A total of 1319 different adult C. *signifera* was captured in the pitfall traps surrounding the study pond. Only 30 individuals (or 2.3%) were carrying *Batrachomyia* larva. There was no difference between the percentages of female (19 of 786 = 2.4%) and male (11 of 533 = 2.1%) frogs found to be carrying a parasite ($\chi 2$ = 0.14; 1 d.f.; P<0.50). Fifteen of the 19 female frogs found with parasites had oviducal eggs when entering the pond and so were considered to be ready to reproduce. Three of these were subsequently recorded to have laid a clutch of eggs.

Larvae could be large compared to the host frog, with the longest larva extending approximately 70% along the length of a frog. On removal, one of the largest larva was found to represent 7.1% of that frog's remaining mass. Two frogs were found carrying two fly larvae. One of these individuals possessed a small (<10% of SUL) and a large (>50% SUL) larva while the other frog was found carrying two larvae of roughly equal size (approximately 40% of the frog's SUL).

No unparasitised frog was subsequently recaptured with a larva. No frog captured carrying a larva was ever recaptured.

Female frogs had a mean body condition of 0.045 for parasitised frogs and 0.051 for a random selection of unparasitised individuals of the same size classes. These values were not significantly different (t-test; 31 d.f.; t = 0.579; P = 0.065). For males the mean condition was 0.035 and 0.038 for parasitised and unparasitised frogs respectively, which was significantly different (16 d.f.; t = 1.88; P = 0.039). Not enough frogs were infested with two parasites to analyse if this additional parasite load was sufficient to have an added impact.

DISCUSSION

It was expected that individuals of *Crinia signifera* found carrying a parasite would show a significantly reduced body condition compared to unparasitised frogs. The largest *Batrachomyia* larvae were approximately 70% of the length of male frogs and caused a conspicuous bulge on the side and so should represent a considerable burden. A parasite larva would remove a considerable amount of blood from the host frog in reaching a size suitable for metamorphosis and so make it difficult for the frog to maintain a condition similar to unparasitised frogs. Both male and female parasitised frogs had a poorer body condition, but this was significant at the 0.05 level only for males. It is likely that the larger body size of a female frog counts in its favour when carrying a *Batrachomyia* larva, reducing the negative effects to less significant levels. A larva is relatively smaller on a female compared to a male and any tissues or fluids removed are a lesser percentage of a female frog's body mass. An extension of body condition effects would be to compare the relative clutch masses of parasitised and unparasitised females to see if this was significantly affected by the presence of larvae. The data obtained in this study was insufficient to make such a comparison.

Krefft (1864) considered that all frogs died when the larvae emerged from under the skin, but both Skuse (1889) and McAlpine (1955) considered that this was not the case and the larvae emerged without directly killing the host frog. In this study the absence of recaptured parasitised frogs was most likely to be an artefact of the low long-term recapture rates where only 8% were recaptured after more than 6 months (Lemckert and Shine 1993). The chance of recapturing a frog after this time was low and the number of parasitised frogs was also small. A small percentage of parasitised frogs may have died some time after the fly emerged due to infection (McAlpine 1955), which would further decrease the chances of recapturing a parasitised frog. In future investigations, parasitised individuals need to be kept in captivity in order to document with more certainty what happens to frogs after the fly has emerged.

It appears that frogs are be able to cope with even a major reduction in body condition as this genus of parasites has been recorded to have had a more dramatic short-term effect on another species of frog. An adult northern corroboree frog *Pseudophryne pengilleyi* has been observed to have the majority of its abdominal region collapse as a result of tissue loss, yet the individual was able to recover fully (A. White, pers. comm. 1998). This again suggests that death is unlikely to be a direct result of having a parasite.

One other frog species utilising the study pond was also found to be parasitised by *Batrachomyia* flies. This was the smooth toadlet *Uperoleia laevigata* with two captured individuals having a larva present in their parotoid glands. A visual inspection indicated that these frogs were in relatively good condition and had suffered no obvious debilitation as a result of the presence of the larva. However, I did not obtain data with which to confirm this assessment. The parasitism rate was much lower for this species with only 0.003% (2 of 730) of frogs captured being found to host a larva (compared to 2.3% for *Crinia signifera*). It is not known if the species of *Batrachomyia* parasitising the smooth toadlets was the same as that on the common froglets. If it was a different species, it may explain the different rates of parasitism observed.

Another possible effect of the presence of a parasite could be the chemical "castration" of the host frog to inhibit lipid transport and so inhibit egg development. Such an effect on the host has been suggested with locusts and nemestrinid flies (Horwood and Hales 1991) and silkworms and tachinid flies (Hayakawa 1987). There is no indication of such a system working in this study. Of the 19 females captured with a *Batrachomyia* larva, 15 had obvious oviducal eggs and were ready to reproduce when they entered the pond area and three were recorded to have definitely produced a clutch of eggs. The possible castration of males could not be assessed, although males with parasites have been seen to call (pers. obs.). Future studies may benefit from looking at the lipid content of parasitised versus non-parasitised frogs.

In conclusion, the presence of a *Batrachomyia* larva in a frog of the species *Crinia signifera* at Darkes Forest resulted in a significant reduction in the condition of males and a non-significant reduction in the condition of females. Parasitism rates for other populations of C. *signifera* may be higher, with McAlpine (1955) finding 26 of 93 *Litoria phyllochroa* sampled (28%) carried 1-3 *Batrachomyia* larvae. If such severe infestations were to occur, and particularly if individuals were subjected to multiple successive larvae, significant impacts may be found on both sexes.

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